NEW FACILITIES FOR PLANT PATHOLOGY RESEARCH

CANADA DEPARTMENT OF AGRICULTURE
OTTAWA, ONTARIO

Introduction

Since 1950 the Canada Department of Agriculture has been and still is engaged in a multi-million dollar research laboratory building program.

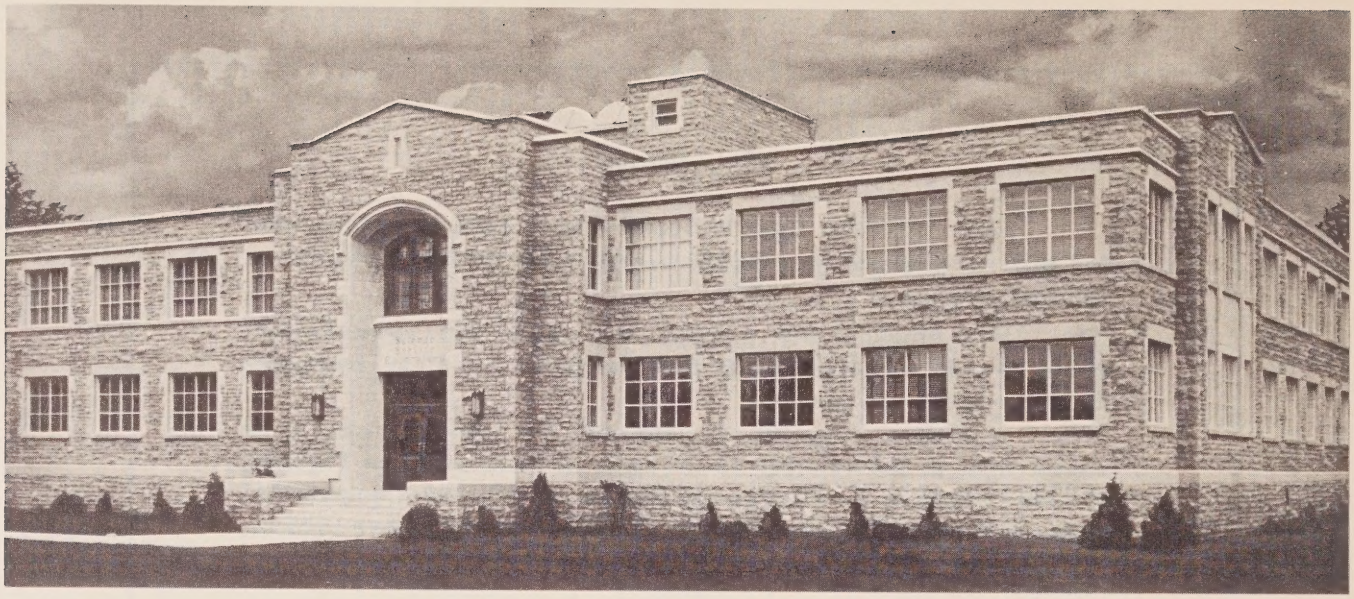
This brochure will acquaint the reader with those centers where in the past eight years new facilities for plant pathology research have been provided.

At this writing, future plans call for new facilities to be established in laboratories to be built at Vancouver and Victoria, British Columbia; Lethbridge and Edmonton, Alberta; Quebec City, Quebec; Fredericton, New Brunswick, and Kentville, Nova Scotia.

NEW FACILITIES FOR PLANT PATHOLOGY RESEARCH

Canada Department of Agriculture

1951 – Science Service Laboratory, London, Ontario.
1952 – Science Service Laboratory, Ste. Anne de la Pocatiere, Quebec.
1952 – Science Service Laboratory, St. Jean, Quebec.
1953 – Science Service Laboratory, Charlottetown, Prince Edward Island.
1953 – Forest Pathology Laboratory, Maple, Ontario.
1954 – Forest Biology Laboratory, Fredericton, New Brunswick.
1958 – Canada Agriculture Research Laboratory, Winnipeg, Manitoba.
1958 – Canada Agriculture Research Laboratory, Saskatoon, Saskatchewan.



LONDON, Ontario.

During the last decade the application of chemistry to problems of controlling agricultural pests has assumed far greater importance than ever before, and developments continue at a breath-taking pace. Manifestly, the widespread use of toxic chemicals in field, orchard and elsewhere is certain to produce effects other than those intended. As example, reference may be made to the destruction of beneficial insects and the development of resistance, or tolerance, on the part of pest species. Similar, if less striking, complications may be expected from the use of herbicides, fungicides, soil fumigants, etc. Certainly our knowledge of the long-term effects of current practices is inadequate.

New agricultural chemicals appear on the market each year, many with important physiological effects on plants and animals. "Chemical control" exerts a powerful influence on agriculture; and the main function of the new laboratory is to direct this influence so as to benefit agricultural production.

The London Laboratory has been well equipped and, as far as quality is concerned, well staffed. The work will have an important bearing on many diverse fields of agricultural research in Canada and elsewhere.

The work of the Laboratory may be classified under three general fields of research.

1. *To investigate the ecological effects of the use of agricultural chemicals (other than fertilizers) with the purpose of ensuring that the widespread or continued use of such chemicals, e.g., insecticides, fungicides, weed-killers and growth-promoting substances, will not have harmful consequences on soil fertility, beneficial organisms and crop quality.*
2. *To co-ordinate departmental research on the application of chemistry to problems of applied entomology and plant pathology and to advise on problems associated with the use of chemicals for this purpose.*
3. *Post-graduate training in the laboratory methods and techniques of crop protection and the critical examination of field problems.*

A distinctive feature of the Laboratory is the opportunity which it provides for the co-ordination of chemistry, zoology and botany, in a unified attack upon these problems.

Regarding plant pathology research at London in particular, the number of new fungicides is growing quickly and, by laboratory methods, it is possible to assess fungicidal activity and the probable way in which fungal growth is inhibited.

Moreover, in certain groups of diseases, the nature and cause of plant damage is becoming known. It is this knowledge which opens up the important possibility of rendering the plant systemically resistant to the effects of fungus attack.

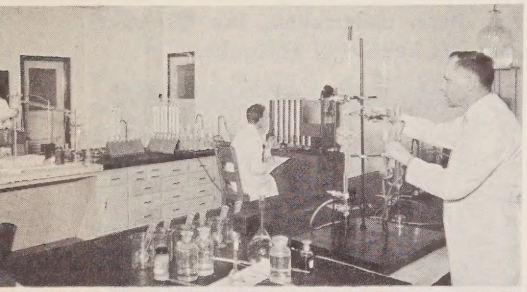
Another field of work concerns processes of fungal antagonism in which a specific chemical or "antibiotic" is involved. If the properties and stability of the "antibiotic" are known, a logical basis is provided for the development of practical methods of crop protection based on the encouragement of fungi antagonistic to pathogenic fungi.

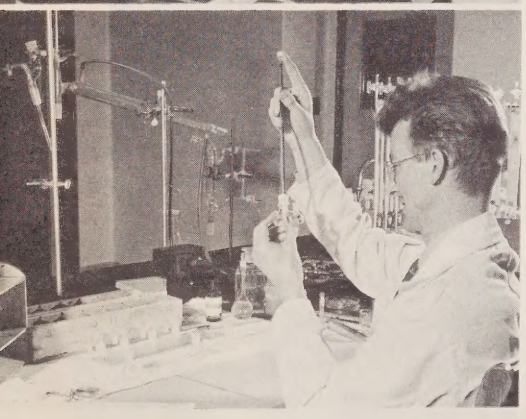
STE. ANNE DE LA POCATIERE, Quebec.

In the 30 years during which plant disease investigations have been carried on by federal pathologists at Ste. Anne de la Pocatière, the growers in eastern Quebec have had the opportunity of consulting with specialists on various diseases affecting their crops. Apple and potato diseases have received the most attention. At the same time, more attention is being given to disease problems of orchard and small fruits. vegetables and field crops.

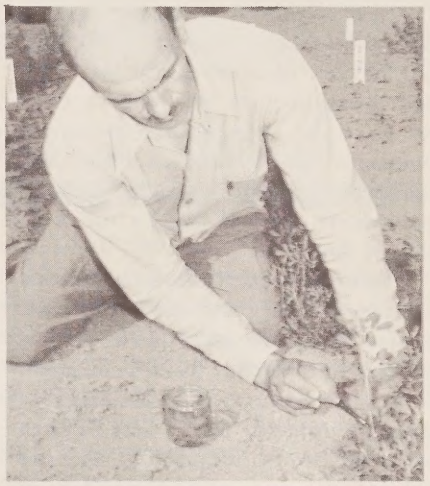
Research is being focused on late blight, bacterial ring-rot, and virus diseases of the potato. Spray tests, made over the past 20 years with bordeaux mixture, have yielded important information and the pathological observations have been helpful in applying knowledge gained. Advice from the Plant Pathology unit has kept the grower informed as to the exact time he should spray, saving him the expense of unnecessary applications. As for studies on virus dissemination in potatoes, these have shown, over many years, that the production of certified seed should be restricted to northern Quebec where annual infection is low compared with the conditions in the western districts of the Province. These studies have been carried on in co-operation with the Quebec Department of Agriculture. More recent observations show that it would be much more economical to plant small-size tubers instead of cutting large tubers for seed. Small tubers from certified or foundation stock do not carry any more virus than large tubers. This practice, it has been found, eliminates the danger of spreading bacterial ring-rot which is considered the most serious problem confronting potato growers in the Province.

Botanical studies are also carried on in the Plant Pathology unit. The behaviour of native and introduced plants in their habitats is under study for the national and the local herbarium. Collections of plants are made with a view to providing as representative material as possible of the plant groups. Information regarding native and introduced plants is given to the public, agricultural agents and other agricultural workers. In some cases, the research studies are closely related to those of the plant pathologist, soil specialist, plant breeder or other agricultural experimentalist.





Top: Plant Physiology Laboratory. L.J. Coulombe, and R. Paquin. Physiological studies are undertaken to determine effect of disease organisms on plants. Bottom: Roger Paquin determining enzyme activity in connection with the influence of lycomarasmine on plant respiration.



Top: R.O. Lachance inoculating alfalfa plants with the wilt bacterium to test disease resistance. Centre: H. Généreux examining potato roots for disease. Bottom: R.O. Lachance, J.C. Perrault and H. Généreux examining the result of seed disinfection tests for cereal smuts.

ST. JEAN, Quebec.

The Plant Pathology Section was first established at the Botanical Garden in Montreal in May 1948 and transferred to St. Jean in 1949. At first its main objective was to continue experiments on fungicides for the control of apple scab, previously carried out by the Fruit Insect Section.

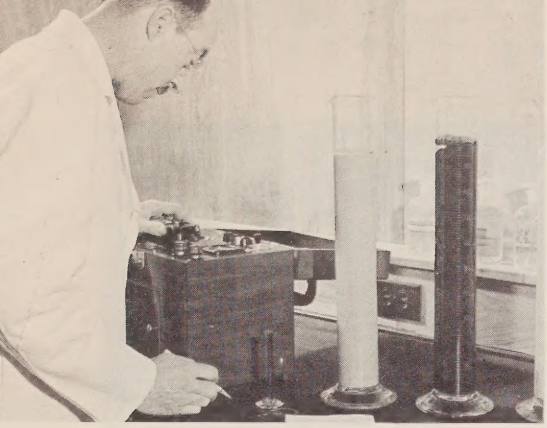
Research on orchard fungicides, both protectants and eradicants, continues to be the main plant disease project at St. Jean. Each year manufacturers release new products for disease control. These may be highly specific in respect to the diseases they control, the regions where they are used, and the conditions under which they are applied. The St. Jean Laboratory tests these newer fungicides and compares them with others now in use, studying their effectiveness against apple scab under local conditions. A few of the important practical applications that have resulted from these tests are the use of ferric carbamate in place of sulphur fungicides for cover sprays, the recent introduction of glyodin for early sprays, and the replacement of lime sulphur as an eradicant by organo-mercuries.

In the course of these tests, observations are made on the influence of fungicides on the growth and yield of apple trees and on the quality of the crop, factors which are too often neglected. The biology of the apple scab fungus and the influence of seasonal weather conditions on its development are being studied to help the grower forecast scab infections and time his sprays. Spray machinery is also being tested. At the request of the grower, experiments are carried out in co-operation with the Fruit Insect Section, to compare different sprayers and determine their effectiveness in pest control. Machines that have proved to be satisfactory in other parts of Canada are tested under Quebec orchard conditions. Results obtained in these different experiments are used extensively in the preparation of orchard spray guides issued by the Provincial Department of Agriculture. Provincial technicians work closely with the laboratory and cooperate in many ways.

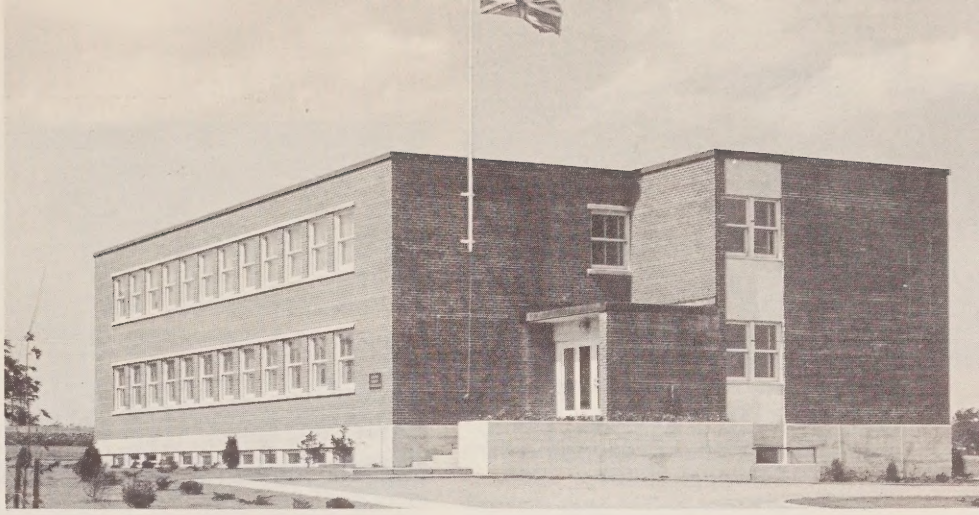
In the laboratory, research is going ahead on new ways of controlling apple scab, including the use of antibiotics. An attempt is being made to find out why some varieties of apples are resistant while others are susceptible.

Vegetable growing in southwestern Quebec is important, and diseases on some crops are troublesome and lower yields. As yet no extensive research on vegetable diseases has been undertaken, but the need for it is becoming apparent.

Below: R. Crête isolating the beet leaf-spot fungus, Cercospora beticola. Right: L. Cinq-Mars estimating amount of scab infection on apple foliage.



L.C. Callbeck studying physical and chemical properties of new potato fungicide.



CHARLOTTETOWN, *Prince Edward Island.*

Research on plant diseases touches all the important crops grown on the Island. Projects include studies on such minor-element deficiencies as brown heart in turnip, caused by lack of boron; magnesium deficiency of potato; and the whiptail disease of cauliflower, caused by lack of molybdenum. Other studies relate to club root of crucifers, fungicides, the use of potato vine killers, and such potato disorders as blackleg, late blight, and the several wilts and rots that attack this crop.

Because approximately 50 per cent of Canada's exported seed potatoes are produced in Prince Edward Island, and because of the high quality of Island table potatoes, the potato is the leading cash crop and its diseases have received the most attention. Some problems have been solved, others are under long-term investigation, and new ones are constantly arising. At the same time the diseases affecting other crops are not neglected. The Island is an important exporter of turnips, ranking second only to Ontario in this respect. Also there is a trend towards heavier production of horticultural crops such as beans, tomatoes, peas, cucumbers, strawberries and other small fruits, all of which are subject to destructive diseases.

Significant information has been obtained on club-root of crucifers. It has been demonstrated that the causal organism has several races, differing in their abilities to cause infection. Also, irrespective of varietal reaction to club-root, there exists an equal degree of infection within the root hairs; nor is the intensity of infection in the root hairs associated with the extent of clubbing.

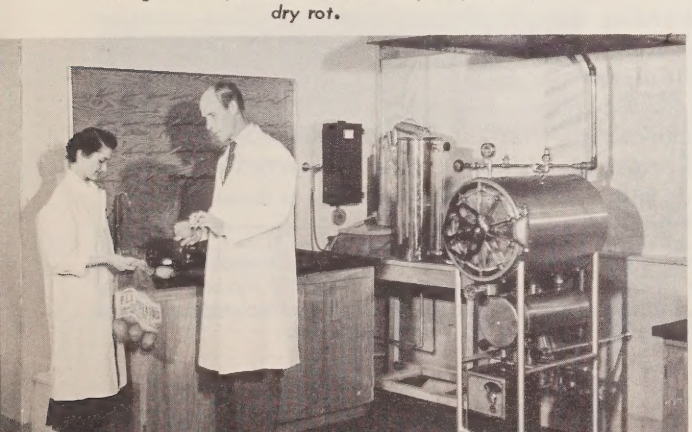
One notable contribution made by the Laboratory to the welfare of agriculture has been a study of the effects of varying the proportion of lime in Bordeaux mixture for potato spraying. This study was begun during the period when Bordeaux mixture was being challenged by factory-prepared but more expensive fungicides. It resulted in the introduction of low-lime Bordeaux, a spray that has been adopted by growers in all the potato-growing areas of Canada. In Prince Edward Island alone this mixture, because of its effectiveness and low cost, has saved the industry many thousands of dollars annually.

This Laboratory took a leading part in investigating and promoting potato vine killers. The laboratory and field investigations into this aspect of control of tuber rot from late blight have given the growers a supplementary means of reducing losses from this disease.

It has been found that Verticillium wilt of potatoes can be controlled by treating the tubers with an appropriate fungicide. The results of these investigations have confirmed the desirability of seed treatment.

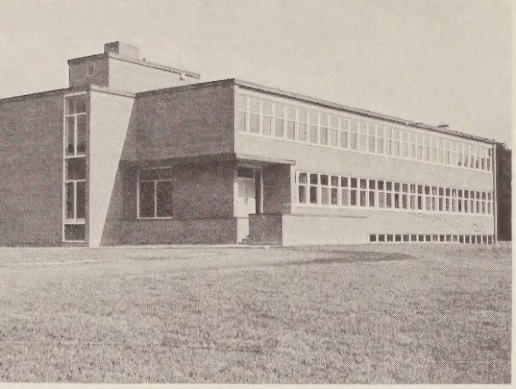
Storage rots, always of great concern to the potato industry, have necessitated extensive investigations. The problem is being attacked in the field as well as in the laboratory, and controlled low-temperature chambers permit a study of the behaviour of these and other storage disorders under a variety of environmental conditions.

Sterilizing and inoculation laboratory with G.W. Ayers demonstrating special inoculating technique used in the study of potato dry rot.



HISTORICAL SIDELIGHT

Paul A. Murphy, the first Plant Pathologist-in-Charge, said in his 1916 report: "The Charlottetown Laboratory is unique in several ways not only in the Dominion but elsewhere for it is a field laboratory in the truest sense of the word. Planned on strictly utilitarian lines and with its main purpose kept clearly in view, it provides all the accommodation required at the moment." With this small beginning, Dr. Murphy initiated a program of research on potato diseases. The value of this research was reflected in the rapid development of a sound inspection service for seed potatoes, centred at the laboratory and continuing to the present as the watchdog of the seed potato industry. Late blight, blackleg, virus diseases, and storage disorders, prominent in potato production, offered challenges that were accepted in an expanding program.



New laboratory is located on the Southern Research Station of the Ontario Dept. of Lands and Forests at Maple, Ont.; built by the Province, it is staffed by the Federal Dept. of Agriculture.

MAPLE, Ontario.

The Forest Pathology Laboratory at Maple is modern in all respects, furnishing the best facilities for fundamental and practical research, and is the result of federal-provincial co-operation. This two-storey building is provided and maintained by the Ontario Department of Lands and Forests as its part in a co-operative scheme directed towards the prevention or control of losses caused by tree diseases. The Science Service, Canada Department of Agriculture, through its Forest Biology Division, is responsible for staffing and administering the new facilities.

The location of the Laboratory is well chosen. Here in very close proximity to other laboratories conducting research in silviculture and related fields, forest pathologists may discuss mutual problems and engage in co-operative research with the greatest ease.

The Maple Laboratory operates field stations at the Petawawa Forest Experiment Station and at the University Forest, Dorset. These field establishments together with other project activities insure a full degree of co-operation with the Federal Forestry Branch of the Department of Northern Affairs and National Resources, the Faculty of Forestry of the University of Toronto, and Forest Industry. Laboratory personnel give courses of instruction on forest pathology to the undergraduate students of the Faculty of Forestry and to those attending the Provincial Ranger School at Dorset. For the investigation of the diseases mycological services are required for the identification of disease-causing organisms. In this work close co-operation is maintained with the Mycology Unit, Botany and Plant Pathology Division, Science Service, and the Department of Botany, University of Toronto.

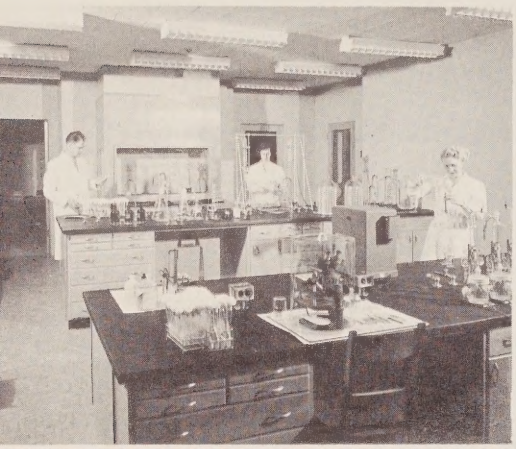
Research Program

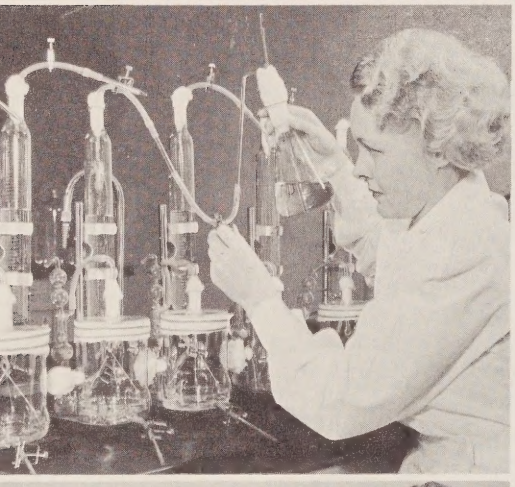
The Forest Pathology Laboratory at Maple conducts research on diseases of forest trees throughout the Province of Ontario. The major problems of study have been divided into sections with a project leader in charge of each. Some of these are based on the need for information concerning the pathology of a major tree species; others deal with one disease of outstanding importance; and still others deal with problems involved in forest management.

The work of these projects is co-ordinated by the officer-in-charge, who is responsible to Divisional Headquarters in Ottawa.

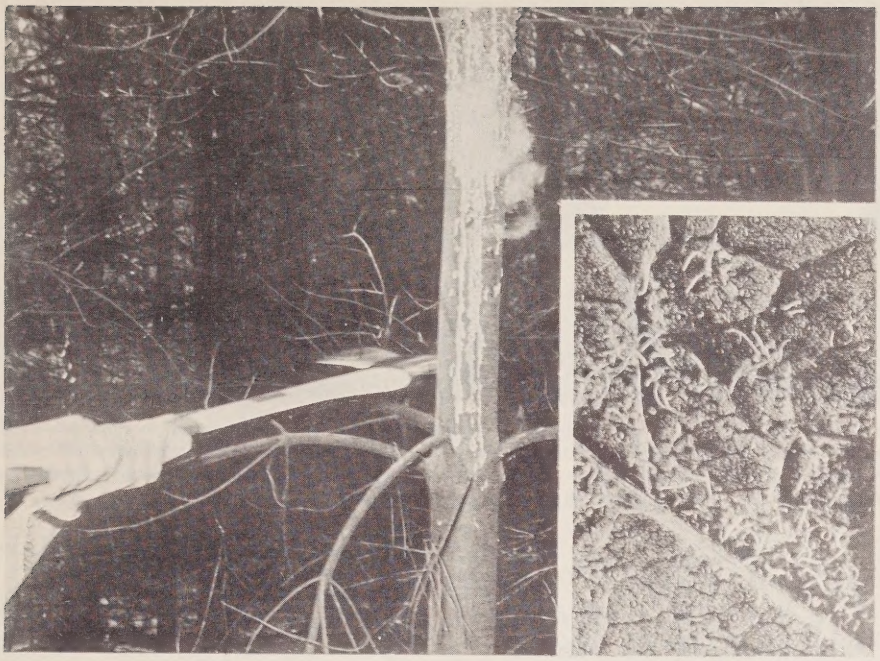
Although preference is given to the study of forest disease problems of Ontario, the general scope of the studies conducted at the Laboratory is not limited. Studies of problems common to other parts of Canada and to the adjoining United States are integrated through a number of national and international committees, which review the work in progress and discuss the contributions made by several researchers toward a final solution.

A small section of the Forest Zoology Unit is associated with the Maple Laboratory. This section deals with infestations and damage caused by insects attacking shade trees, ornamental trees, and nursery stock. Insecticides are tested to find the most effective materials for the control of insect damage.





Top: Laboratory units have large research area and adjoining office, storage and utility rooms. Mycorrhizal and tree physiology are studied in the unit shown. Centre: Mycological Studies. Miss L.C. Baumel operates equipment in which substances exuded by mycorrhizal fungi are collected. These substances play an important role in tree development. Bottom: J. Cockerill inoculates soil in which tree seedlings will be grown with a fungus suspected of causing damping-off; healthy seedlings are in foreground pot.



Left: White pine blister rust, a menace to continued production of white pine lumber, is a disease which alternates between white pine and currants and gooseberries. Inset: Ribes spp.

Work on the biology and pathogenicity of several organisms is being done to find an explanation for the sporadic and destructive occurrence of seedling mortality. Research is underway for preventing or reducing damage by cultural methods aimed at rapid, vigorous seedling growth and a decreased incidence of disease pathogens.

Other nursery and plantation projects include the study of nutritional and physiological problems which stem from adverse soil conditions. Particular attention is also being given to diseases relating to the development of hybrid and native poplars.

The spread and intensification of white pine blister rust in Ontario have been observed and recorded over a number of years. Systematic surveys have established the regions where white pine blister rust is building up. The most serious aspect of the problem is the danger to reproduction and second growth pine upon which depends the future of the white pine industry.

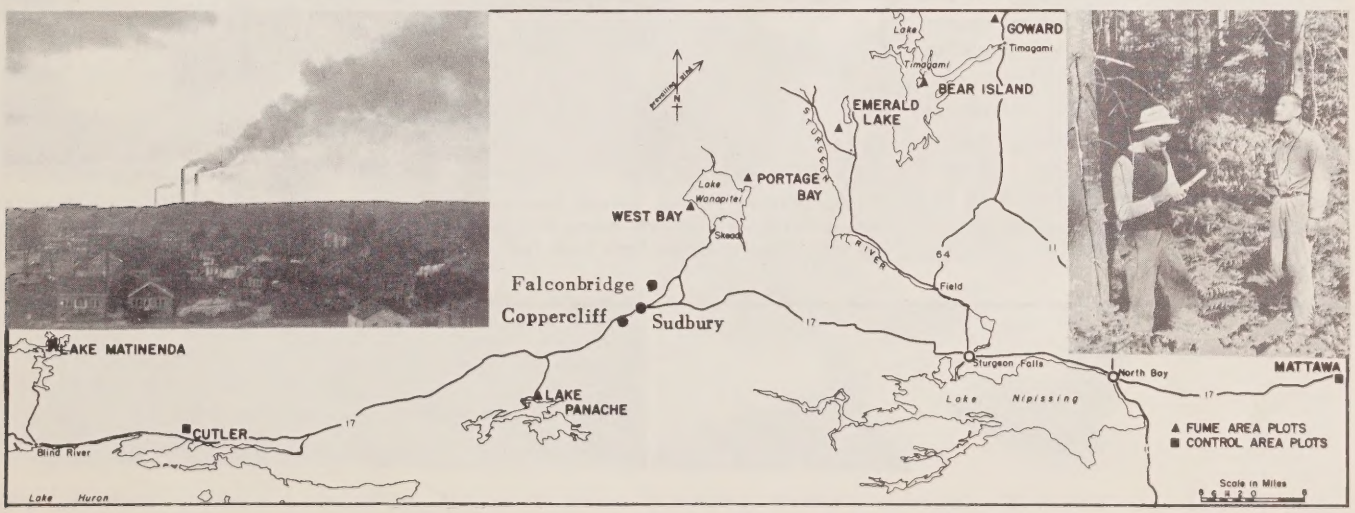
It is evident that there are areas of high hazard in productive white pine stands. Local control through the eradication of the alternate host would be possible in these areas and, indeed, is necessary if white pine is to continue to be grown. Studies on the biology of the causal fungus are continuing. Pathologists are co-operating with Dr. C.C. Heimburger, forest geneticist, Ontario Department of Lands and Forests, in tree breeding studies to develop a white pine resistant to the disease. Dr. Heimburger is also undertaking research on hybrid poplars.

For some years foresters in Ontario have expressed concern over a number of tree disorders which are recorded as arising from physiological causes. In these diseases there is no evidence that an organism is in itself responsible for a pathological condition. Initial approaches to these problems provided useful evidence on the intensity and progress of the disorders but did not lead to experimental results demonstrating the causal factor or factors. Later it was recognized that there was a need for fundamental knowledge in tree physiology, forest soil microbiology, and biochemistry, to provide basic data for an understanding of the development of healthy and unhealthy trees.

Consideration was given to the inter-relationships of the substances produced by roots and by the mycorrhizal organisms which are beneficial to root growth and survival. Preliminary results indicate that tree vigour and health are closely interwoven with the development of forest soil microflora (bacteria, mycorrhizal fungi and other soil micro-organisms) occurring in association with root systems.

Among physiological diseases may be mentioned white pine needle

Air Pollution Studies. Currently, investigations on the possible effects of fumes on stand density, composition, increment, and regeneration are in progress in the pine-producing areas in the Sudbury and Timagami districts of Ontario.



Location of Permanent Sample Plots

Left to right: Decay studies. Yellow birch log is scaled according to Ontario Log Rule and gross volumes of decay and net merchantable volumes computed for each log. In the Mycological Laboratory, Mrs. A. G. Davidson removes a portion of a fungus growing on agar for microscopic examination in the identification of wood-destroying fungi. Jack Basham (right) uses machine built at Queen's University for testing the impact breaking strength of wood sticks in various stages of decay.

blight and the deterioration of yellow birch. Another type of physiological disease arises from unfavourable air or soil conditions caused by industrial processes, e.g., fume injury in the vicinity of mills processing sulphur-containing ore. Studies on the possible effects of fumes on stand density, composition, increment, and regeneration are in progress in pine-producing areas in the Sudbury and Timagami districts of Ontario.

The importance of decay studies to forest management has been recognized and the procedures developed as the result of pathological research are now being applied by Industry and the Provincial Government. The Maple Laboratory retains its connection with this work by continuing the fundamental biological studies on the fungi responsible for the decay.

Closely related to these studies are those which deal with the deterioration of stands killed by fire and insects. A clear knowledge of the deterioration rate may permit the salvage of valuable timber before insects and decay make such an operation unprofitable. The Forest Pathology Laboratory conducts studies related to the deterioration of budworm-killed spruce and balsam fir and of fire-killed pine in co-operation with the forest entomologists.

An organized Forest Disease Survey was instituted in Ontario in 1951. It provides a background of knowledge of disease conditions in the forest. Ecological aspects of disease are stressed and extensions made in our knowledge of geographical distributions and host ranges. The Survey is conducted through the activities of a basic staff of 23 forest biology rangers who travel throughout each forest district. The efforts of this group are augmented by those of many co-operators representative of the forest industries, governmental services, and the public. Disease samples collected in all forested areas are shipped to the Maple Laboratory for identification and interpretation.

The present program of the Forest Pathology Laboratory involves studies of diseases attacking seedlings and immature and mature trees. There are many diseases which attack trees during their life span and must be considered in choosing the crop and deciding where and how to grow it. It is evident that forest pathology must play an important role in the application of management plans whose purpose is to ensure an adequate supply of wood material from present and future forests.

Forest Disease Survey. Several thousand samples are received annually from co-operators throughout Ontario. In coldroom, Mrs. R. Cuthbert selects samples of diseased wood from which causal organisms have been isolated and identified for inclusion in the mycological herbarium.

FREDERICTON, *New Brunswick.*

The Canada Department of Agriculture in 1954 opened a new laboratory on the campus of the University of New Brunswick at Fredericton to serve as a headquarters for research and survey work on forest zoology and pathology in the four Maritime Provinces. The laboratory, which is administered by the Forest Biology Division of the Department's Science Service, is concerned with problems affecting the health of trees, particularly insects and micro-organisms, such as fungi, bacteria, and viruses. The main objectives of research are: to determine the species of insects, fungi, and other plant and animal life concerned; to work out their biology and relationships to the forest environment; and to discover how damage can be prevented or controlled. The control of outbreaks must be based on an understanding of their nature and causes. This involves study of the physiology and ecology of trees, as well as the injurious and beneficial organisms associated with them.

Work was first commenced on forest insects in 1916 when a small laboratory was built by the Entomology Division on the campus of the University of New Brunswick. This was enlarged in 1936. In 1946 a laboratory for the study of forest pathology was established. Five years later a new Forest Biology Division was created to include the Units of Forest Zoology and Forest Pathology. The appearance of new problems, the increasing importance of protection and management of forest resources, and the extension of the work into Newfoundland, have combined to make new laboratory facilities necessary. All the work of the Forest Biology Division in the region has been brought together in the new building, which also provides space for Fruit Insect Investigations and a regional reference library for the Department of Agriculture.

There is often a close relationship between insect and disease problems. Some disease-producing organisms are carried by insect vectors; others favour insect attack. Insect injury is often followed by fungus infection. The joint study of such problems by pathologists and entomologists is facilitated by the new Laboratory.

A continuous Forest Insect and Disease Survey is carried on throughout the region. The field work is undertaken by Forest Biology Rangers jointly with the provincial forest services and industry. Several thousand samples of insect populations and diseased material, including several hundreds of species of insects and types of symptoms, are taken by suitable techniques each year. These are analyzed and reared, or cultured, at Fredericton and also at sub-laboratories at Debert, N.S., and Corner Brook, Nfld. The species are identified and reference collections maintained. Data are accumulated on life-histories and habits, relationships to host trees and forest types, parasites and predators, and abundance.

The forest pathology program includes investigations of the effects of abnormal deviations in soil temperature and moisture on tree rootlets and mycorrhiza (fungi in association with living roots of trees). An im-

Left: Laboratory units are of latest design. This one is devoted to mycology studies in connection with forest disease research. Right: Miss R. Robinson, in mycology laboratory, preparing wood-rotting fungi for identification by microscopic examination.

portant phase of the research being conducted concerns the antibiotic properties of soil fungi as they affect the production of mycorrhiza which are beneficial to tree vigor and growth. A lack in balance between rootlets and mycorrhiza could be an important factor predisposing trees to disease and insect attack. Although the immediate emphasis is being placed on yellow birch, other species are being observed.

In order to discover the environmental factors that favour the initiation and progress of fungus infection of wood in living trees, observations are being made on the various conditions in the forest associated with decay. Also being followed is the succession of fungus flora in killed trees as deterioration following death advances to the stage where no merchantable volume remains. Pathologists and entomologists work together in relating fungus attack to the presence of wood borers and bark beetles.

To obtain a precise inventory of the merchantable volume in a forested area the amount of decay in each tree species must be known. This information assists the forest manager in making decisions on policies regarding length of rotation, cutting cycles, and methods of cutting. Studies on the amount and type of decay in living trees show that there is a close correlation between age of a given species and the amount of cull due to decay in a stand. Differences occur also between areas and possibly between sites. Present studies are attempting to show the relations between the rate of decay and stand composition, past stand disturbances, length of growing season, and other environmental influences. Deterioration of trees that have suffered seriously from birch dieback is a major problem of this category.

This involves study of the decay-producing fungi in pure culture in the laboratory to determine their optimum requirements and their tolerance to extremes of nutrient concentrations, acidity, temperature, and partial pressures of gases.

Other diseases that require study before diagnosis is positive and control can be recommended are: the rusts (especially white pine blister rust), needle casts, leaf spots, nursery diseases, and symptoms of varying nature on ornamental trees.

To determine the total effects of diseases, long-term stand development studies are necessary. With sampling on an area basis to calculate net merchantable volume produced at various ages. An area is being developed for this type of study.

Studies of virus diseases of trees are a recent development at this Laboratory. Symptoms of disease or insect injury are deviations from the normal and are recognized through changes in anatomical structure or physiological behaviour. Knowledge of normal anatomy and physiology is essential to the recognition and study of these abnormal conditions. Research is being conducted on the movement and storage of water and their relation to anatomy and cell structure in some of the more important tree species. Studies are also being made of the effects of defoliation on photosynthesis and growth.

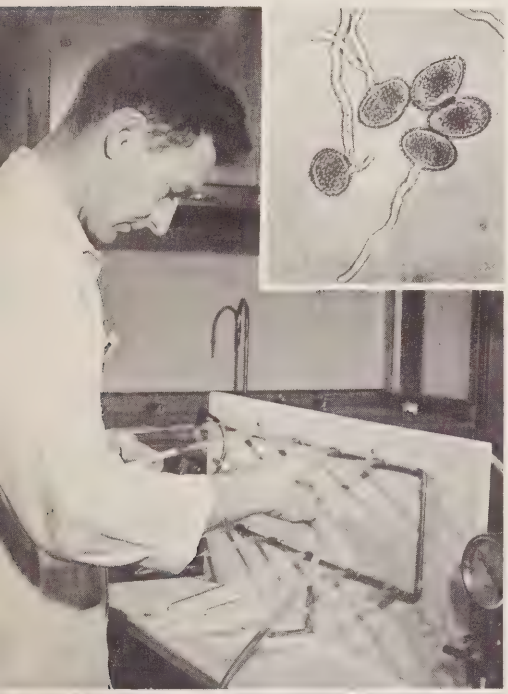
M.A. Stillwell examining specimen infected with white pine blister rust sent in by the Forest Disease Survey

Physiological studies. Demonstration of injection technique used by Dr. K.N.H. Greenidge to trace movement of moisture in healthy and deteriorating birch trees. Dye solution (right) stains wood, outlining path of movement.

D. R. Redmond measuring soil temperatures employing potentiometer in soil-heating studies as part of the investigations of rootlet mortality and birch dieback. Wires lead to thermocouples in soil.

New Canadian Department of Agriculture Research Laboratory

WINNIPEG, *Manitoba.*



The work of the Plant Pathology Section is largely confined to fungus diseases of cereal crops, oilseed crops, and forage crops while bacterial and virus diseases and seed treatments also come in for study. Diseases of other crops are investigated when circumstances warrant and advice is given, as far as this is possible, to anyone who seeks it. The plant pathologists work jointly with the cerealists, one group advising on matters of rust resistance, the other on breeding and production of new varieties.

Rust research cannot be done effectively without a knowledge of the year-by-year situation in respect to the occurrence of rust races. To acquire this knowledge, surveys are made annually to find out which races are present in different parts of Canada and to determine whether new and more virulent races have appeared. For example, the appearance of race 15B was determined far enough in advance to permit the plant breeders sufficient time to develop Selkirk. These surveys are carried out not only for stem rust and leaf rust of wheat but also for stem rust and crown rust of oats, leaf rust of barley and the rusts of flax and sunflowers. Studies are being conducted on the genetics of the rust organism, including hybridization and mutation which may give rise to new physiologic races. Another important study concerns the physiology of host-parasite relations in order to understand the nature of rust resistance and thereby assist the plant breeders in developing resistant varieties.

The nearby 32-year-old Rust Research Laboratory.

Top: Technician J.H. Campbell evacuating air from glass tubes used for rust spore storage. Inset: Red spores of stem rust germinating. Bottom: Plant pathologist B. Peturson (left) and plant breeder J.N. Welsh co-operate in developing crown rust-resistant oat varieties.

The work on the smuts of wheat, oats and barley follows much the same pattern because the smuts, like the rusts, are composed of parasitically distinct races that change in their prevalence from time to time. Here again, the work of the pathologist guides the breeder in his selection of parental material for his crosses and in the selection of resistant lines that eventually become new varieties.

In recent years, certain foliage diseases of barley have increased to such a degree that they have required special attention if the production of barley was to remain profitable. Changes in agricultural practices, such as the increasing use of the combine and the consequent employment of the straw as trash cover, may influence the prevalence of these foliage diseases.

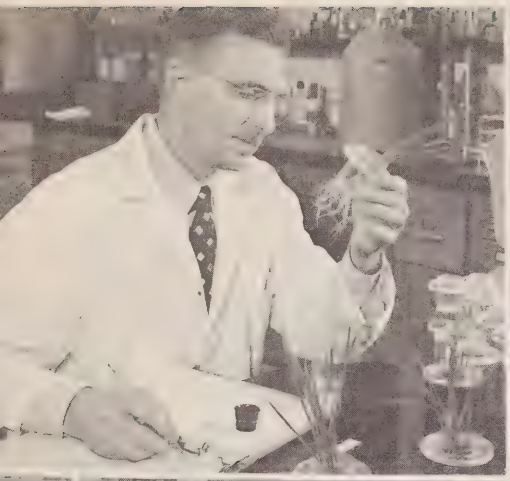
The oil crops, flax and sunflowers, are subject to many diseases of which the rusts are probably the most important. The flax varieties now grown, which are resistant to rust and wilt, provide an example of successful co-operation between pathologists and breeders.

It is only recently that the diseases of forage crops, particularly alfalfa and sweet clover, have received the attention they deserve. The severity of some of these diseases is greatly influenced by the type of soil on which the crops are grown and by cultural practices. With increasing understanding of the factors that influence the diseases, it becomes possible to give sound advice as to their control. Here, also, there is co-operation with the plant breeder who is advised about the disease reaction of varieties.

F. R. Forsyth, plant physiologist, adding reactant to Warburg flask during experiment on respiration of rust urediospores

W.J. Cherewick, plant pathologist, Inoculating wheat with loose smut in the field plots.

Plant pathologist at work: W. L. Gordon, examining cultures in the Fusarium laboratory in study of cereal root-rot.



Left: G.J. Green (left) and T. Johnson determining rust reaction of wheat seedling plants; compartments contain rust cultures. Right: J.E. Machacek examining germinating seeds to determine effects of fungicidal seed treatment.

Top: W.A.F. Hagborg, studying effects of antibiotics on vigor and resistance to disease of cereal plants by means of water culture. Centre: W. Popp isolating promycelial cells of loose smut of wheat by means of a micro-manipulator. Bottom: C.O. Person sectioning diseased plant leaves for microscopic study.

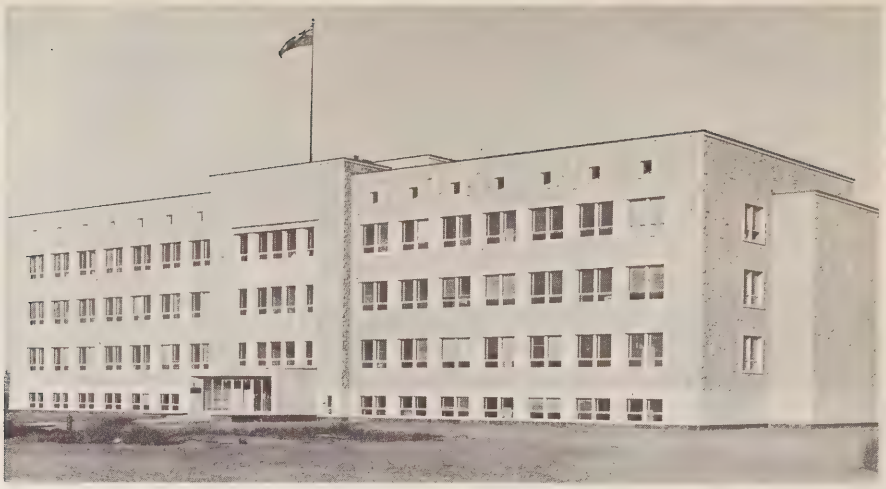
Bacterial diseases of crops such as cereals, peas and alfalfa have been studied in the past, but it is only in recent years that diseases caused by viruses have been investigated. It has been shown that some diseases, such as false stripe of barley, formerly thought to be the result of physiological disturbances in the plant, are actually caused by virus infection. Because of various technical difficulties in the study of viruses there is less known about them than about most other plant disease organisms.

Protection of the young plants against disease by treating the seed with chemicals has gradually been assuming greater importance. This method of disease control has created a valuable market for various kinds of seed treatment materials. The competition for this market among chemical firms has resulted in a very large number of products whose efficacy must be tested. This Section is the main testing centre in Canada for seed treating chemicals as far as cereal and flax are concerned.

Historical

Breeding and Pathology

1916 –Disastrous rust epidemic.
1917 –First Rust Conference, August 16-18, Winnipeg.
1917-24 –Professor W.P. Fraser conducted first Canadian studies on stem rust at Saskatoon.
1924 –Second Rust Conference, September 9-10, Winnipeg.
1925 –Rust Research Laboratory established on campus of University of Manitoba; D.L. Bailey in charge of Plant Pathology and C.H. Goulden, Cereal Breeding.
1925-57 –Until 1949 breeding work was confined to wheat and oats while plant pathology studies were mainly on rusts, smuts, and root diseases. New rust-resistant wheats and oats distributed during this period. Since 1949, barley, flax, safflower and field peas have been brought into program.



SASKATOON, *Saskatchewan.*

The plant disease program mainly concerns the cereal smuts, root rots, and forage crop diseases.

The adaptation of the centrifuge test for detecting smut spores in cereal seed samples and the embryo dissection test for detection of internally borne true loose smut in barley seed, devised by this Section, are in common use today. The development of the water-soak and dip treatments of cereal seed for control of true loose smuts represents a recent contribution of importance. Currently, the work on cereal smuts includes a study of the longevity of spores and mycelium of *Ustilago nuda*, factors influencing infection, such as source of inoculum, environmental factors and physiological characters of the host, and factors influencing the effectiveness of the water-soak treatment of barley seed for loose smut control, including the addition of fungicides. The results of these investigations on smut control have encouraged Saskatchewan seed growers to undertake the production of barley seed free from loose smut and, to further this objective, the Provincial authorities have set aside a large section of the Kelvington district which is to be kept as a "smut-free area". The designation of this area has provided a unique opportunity to study the aerial dissemination of smut spores.

Methods of survey for determination of the prevalence and assessment of the damage of common root rot of cereals were developed here. In 1950, the production in artificial culture of the perithecial stage of *Helminthosporium sativum* (the causal organism of common root rot) has opened the way for genetic studies on sexuality and the inheritance of morphologic and pathogenic characters and a better knowledge of physiologic specialization in this pathogen. At present, studies of *H. sativum* involve the use of chemicals and irradiation as a means of inducing biochemical and morphological mutants for the study of variability in the fungus. Genetic studies on the inheritance of such characters as mating type, spore colour and pathogenicity are under way. Soil microbiological investigations include

Plant Pathology Studies. R.J. Ledingham (left) demonstrating technique in determining the number of Helminthosporium spores in soil samples. R.D. Tinline (centre) treating spores of Helminthosporium sativum with nitrogen mustard, one of the many techniques used to induce mutations; new physiologic races are produced in fungi by induced mutations. At right, B.J. Sallans (left) discusses an interesting case of root rot of wheat with P.M. Simmonds.

studies on the survival of spores and mycelium of *H. sativum* in the soil, antagonisms and antibiotic effects of the soil and seed microflora, and the effect of soil amendments and fungicides on the inoculum potential. Studies on methods of control involve varietal testing, determination of the importance of morphological factors in resistance such as sub-crown internode length, and cultural practices, including crop rotation.

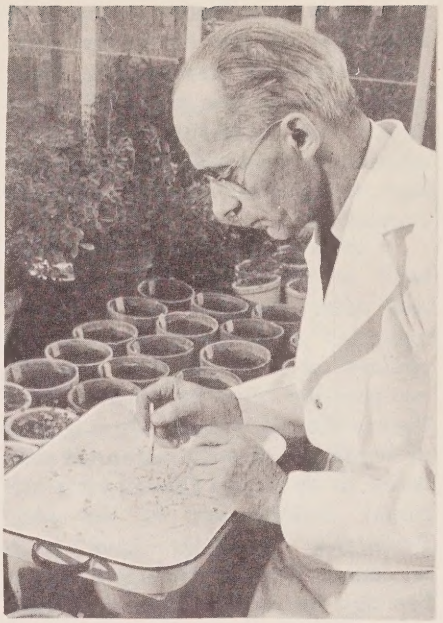
Varietal testing for resistance to black stem of alfalfa *(Ascochyta imperfecta)* and seed treatment trials for control of seedling blight of forage legumes constitute the main research projects on forage crops. Seed treatment trials on rape seed are also being conducted.

Top: S.H.F. Chinn removing specially prepared slide from a soil sample for microscopic examination. He has devised a rapid method of determining certain soil microbiological activities. Bottom: Plant pathologist, R.C. Russell (left) and S.H.F. Chinn, soil microbiologist, discussing the effect of seed treatment for loose smut on the germination of barley.

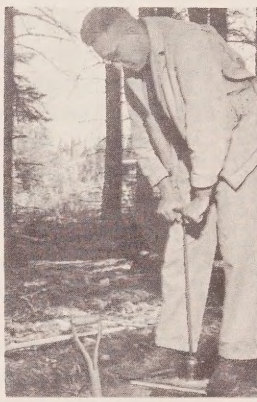
Forest Biology Section

The Forest Biology Section is engaged in studies of diseases of forest trees in Saskatchewan and Manitoba. Trunk decay in white spruce, the most important timber species of the region, has received special attention with respect to age and diameter of trees and the environmental conditions under which they were growing. The volume-of-decay information obtained in this study is used to determine allowances for cull, thus permitting the preparation of more accurate inventories of sound timber. Data regarding the age at which stands should be harvested to avoid excessive loss because of decay have also been compiled. In co-operation with the Saskatchewan Forest Service, this investigation is being extended to include black spruce.

In a study of root rots of white spruce and the effect of sites on the prevalence of disease, extensive mortality was found to occur in patches in spruce stands. Investigations of these "stand openings" indicate that certain soil conditions



H.W. Mead, specialist on forage crop diseases, studies effect of chemical seed treatments.



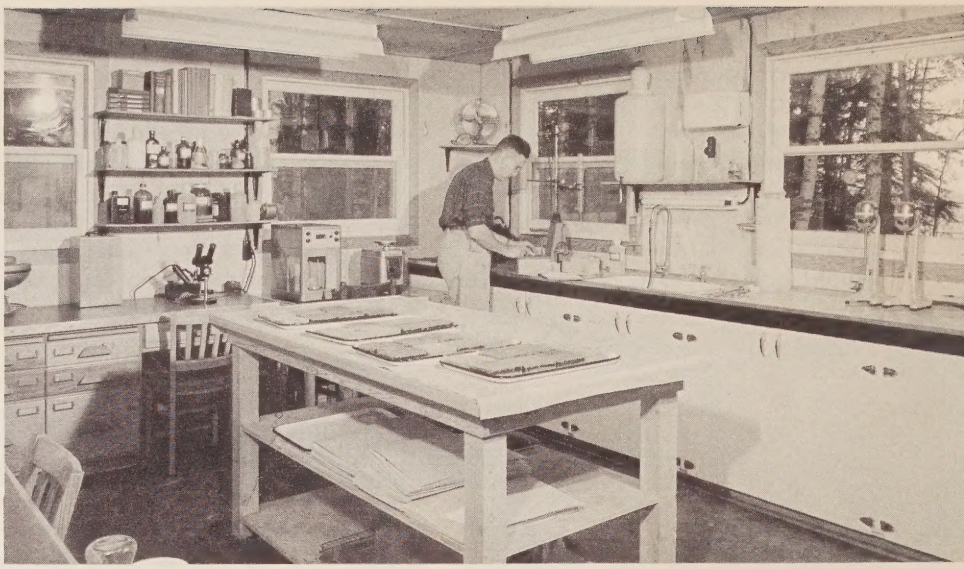
Better-than-average stand of white spruce at Candle Lake, Sask. Forest ecologist, H. van Groenewoud (right) taking undisturbed soil samples in study of soil conditions related to a complex root disease of white spruce.

Forest Biology Studies. Removal of screened immersion plates (left) from soil profile near diseased tree; plates are used for isolating actively growing fungi from soil, and populations from healthy and diseased areas are compared. R.D. Whitney (centre) examining diseased white spruce tree; darker coloured root has been killed by root-rotting fungus, Polyporus tomentosus Fr. At right, tissues occupied by Polyporus tomentosus are recorded at field laboratory, Candle Lake, Sask.

render the trees liable to attack by fungi that kill and decay the roots. The means of recognizing these sites is being sought, so that the stands may be managed on a short rotation for pulpwood production and harvested before the loss becomes excessive.

Considerable progress has been made in controlling "damping off" and other diseases in the forest nurseries of Manitoba and Saskatchewan, some of the work being in co-operation with the Indian Head Forest Nursery Station. Poor growth of seedlings in some nurseries was found to be partly caused by nutritional deficiencies in the soil. Corrective measures have been recommended, with the result that it has now become possible to reduce the production time of certain crops of planting stock by one or more years. A snow mould disease, which in some years has caused important losses in coniferous seed-beds has been controlled by fungicides. Substantial progress has been made in developing practical methods of reducing over-wintering losses in stored planting stock of caragana and other hardwoods for use in windbreaks.

The Forest Disease Survey is a continuing project for providing knowledge of the occurrence, distribution, and importance of all forest diseases throughout the region. This information is obtained by means of reports and specimens submitted by members of the Laboratory staff, by Forest Biology Rangers at the Winnipeg Forest Biology Laboratory, and by foresters employed by the Provincial and Federal governments and industrial concerns. This information is compiled and assessed to give a disease picture of the region.



Interior of ecology field laboratory at the Forest Biology Field Station, Candle Lake, Sask.

Nursery diseases specialist, L.O. Vaartaja (left) makes screening test in small glass dishes to find fungicides useful for tree seeds. Decay expert, W.B.G. Denyer (right) preparing wood from the roots of trees artificially inoculated with a wood-rotting fungus for microscopic examination.

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